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Research on Comprehensive Evaluation of Higher Education

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Abstract: *In recent years, with the development of economy, the development level of higher education directly determines the number and quality of senior specialized talents in a region. However, the level of general higher education in different regions is not the same, and even has great differences. In order to further clarify the ordinary higher education development around the city difference and imbalance, we take He'nan province as an example and select eight related indicators(Number of Schools(unit); New Student Enrolment (person); Graduates (person); Degrees Conferred (Person); Number of Enrolment of Per 100,000 Inhabitants by Level (person) ; Govemment Appropriation for Education (100 million yuan) ; Budgetary Expenditure on Education (100 million yuan); Student-Teacher Ratio (Teacher =1).) to build the index system by using the factor analysis of multivariate statistical methods to study the comprehensive evaluation for 18 cities of He'nan province in 2017 the ordinary higher education level, which is to narrow the gap between local higher education between the city and comprehensively improve the level of higher education to provide the reference.*

Keywords: *higher education, factor analysis, comprehensive evaluation*

1. Introduction

In today's periods, knowledge has become a decisive factor to improve the comprehensive national strength and international competitiveness. Higher education plays an important role in the development of the whole economy and society. In recent years, China's higher education has developed rapidly, and Henan's higher education has also made a historic leap. Henan is a province with a large population, and there are obvious differences in the development level of higher education in different cities. Combining with the social development demand trends in the new period, to build in line with the current direction of development of higher education evaluation system, is helpful to objectively measure the level of higher education around the city, then to comprehensively promote the development of higher education in He'nan province puts forward the feasible policies and measures, make to maximize social benefit and economic benefit of higher education.

A large number of scholars have used the method of quantitative analysis to explore higher education. Alexander and Astin[1] proposed the evaluation index system of the development level of higher education. Zhu et.al [2] obtained the unbalanced development of higher education in various states of the United States through the method of factor analysis. Zhu[3] selected 11 indicators to construct a comprehensive evaluation index system for the development level of higher education, so as to reflect the development level of higher education in various regions. Shen[4] classified the higher education development level of various provinces and cities in China by using cluster analysis method, and comprehensively evaluated the development level of higher education of various provinces and cities in China according to the comprehensive factor scores and classification results. Zhou[5] analyzed and evaluate the development of higher education by factor analysis, and proposed initial reliability recommendations.

This paper selects relevant indexes and uses factor analysis method to conduct quantitative analysis on the development level of higher education in various cities of He'nan Province, objectively presents the situation of the development level of higher education in various cities of He'nan Province, and then puts forward corresponding policy suggestions for coordinating and balancing the higher education level of various cities and improving the overall level of higher education in He'nan Province.

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2. Methodology

2.1 Selection of indicators and data

In accordance with the scientific, objective and operational principles, according to the connotation of the development level of higher education, and considering the availability of data, this study constructs an index system from two aspects of quantity and quality, we select eight specific indicators, X_1: Number of Schools(unit); X_2: New Student Enrolment (person); X_3: Graduates (person); X_4: Degrees Conferred (Person); X_5: Number of Enrolment of Per 100,000 Inhabitants by Level (person) : X_6: Govemment Appropriation for Education (100 million yuan); X_7 Budgetary Expenditure on Education (100 million yuan); X_8 Student-Teacher Ratio (Teacher =1).

The original data of this paper are taken from He'nan Statistical Yearbook 2017. Factor analysis module of SPSS were used to process and analyze the data and get the results.

2.2 Factor analysis

Factor analysis is based on the internal dependence of the correlation matrix of the original variables. Several closely correlated variables are divided into the same category, and each category becomes a new variable. A few new variables can reflect most of the information contained in the original data to describe the relationship between multiple indicators or factors, and then the original variable is expressed as a linear combination composed of several new variables, then the relationship between them is given. This method is called factor analysis.

3. Empirical analysis

Firstly, KMO and Bartlett's test was carried out on the selected indicators, and the test results are showed as follows:

Table 1 KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.797
Bartlett's Test of Sphericity	Approx. Chi-Square	366.715
	df	28
	Sig.	0.000

As can be seen from Table 1, the KMO statistical value is 0.797. According to the KMO measurement standard, this data is generally suitable for factor analysis. The significance probability (Sig) value of Bartlett test is 0.000, less than 0.001, which rejects the null hypothesis and is highly significant. Therefore, it is suitable for factor analysis.

3.1 Common factor extraction

Table 2 Tatal Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.04	75.45	75.45	6.04	75.45	75.45	4.71	58.91	58.91
2	1.24	15.46	90.91	1.24	15.46	90.91	2.20	27.48	86.39
3	0.68	8.50	99.41	0.68	8.50	99.41	1.04	13.02	99.41
4	0.034	0.43	99.84						
5	0.008	0.09	99.93						
6	0.004	0.05	99.98						
7	0.002	0.02	99.99						
8	0.000	0.003	100.00						

In factor analysis, using principal component analysis method, extraction of three public factor, can be seen from Table 2, three factors of the cumulative contribution rate reached 99.409%, it indicates that the three principal component containing the raw data information volume reached 99.409%, with

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the three principal components on behalf of the original eight indicators evaluation of higher education level have enough grasp, so the three factor can be extracted.

3.2 The establishment of factor model

The Rotated Component Matrix is shown in Table 3.

Table 3 Rotated Component Matrixa

Indicator	Component		
	1	2	3
X_1	.938	.330	.062
X_2	.938	.333	.067
X_3	.939	.330	.070
X_4	.922	.366	.103
X_5	.973	.189	.031
X_6	.323	.930	.166
X_7	.407	.894	.173
X_8	.062	.192	.979

The factor analysis model of the index system of higher education level can be obtained from Table 3:

$$X_1 = 0.938 f_1 + 0.330 f_2 + 0.062 f_3 + \varepsilon_1$$
$$X_2 = 0.938 f_1 + 0.333 f_2 + 0.067 f_3 + \varepsilon_2$$
$$X_3 = 0.939 f_1 + 0.330 f_2 + 0.070 f_3 + \varepsilon_3$$
$$X_4 = 0.922 f_1 + 0.366 f_2 + 0.103 f_3 + \varepsilon_4$$
$$X_5 = 0.973 f_1 + 0.189 f_2 + 0.031 f_3 + \varepsilon_5$$
$$X_6 = 0.323 f_1 + 0.930 f_2 + 0.166 f_3 + \varepsilon_6$$
$$X_7 = 0.407 f_1 + 0.894 f_2 + 0.173 f_3 + \varepsilon_7$$
$$X_8 = 0.062 f_1 + 0.192 f_2 + 0.979 f + \varepsilon_8$$

By factor analysis model, the first principal factor f_1 primarily is determined by five indicators : Number of Schools(unit) New Student Enrolment (person); Graduates (person); Degrees Conferred (Person) and Number of Enrolment of Per 100,000 Inhabitants by Level (person), which reflects the higher education level from the level of quantity scale, thus the main factor can be named after the higher education scale factor.

The second main factor, f_2 , is mainly determined by the two indexes : Govemment Appropriation for Education (100 million yuan); Budgetary Expenditure on Education (100 million yuan). Therefore, the main factor can be name after the fund factor of higher education.

The third major factor, f_3, is only determined by the Student-Teacher ratio(Teacher=1) and reflects the level of higher education from the level of quality, which can be named as the quality factor of higher education.

3.2 Factor score

Table 4 is the coefficient matrix of factor score. According to the factor score equation:

$$f_1 = 0.233X_1 + 0.232X_2 + 0.234X_3 + 0.215X_4 + 0.298X_5 - 0.222X_6 - 0.177X_7 - 0.010X_8$$
$$f_2 = -0.073X_1 - 0.073X_2 - 0.077X_3 - 0.048X_4 - 0.205X_5 + 0.673X_6 + 0.606X_7 - 0.194X_8$$
$$f_3 = -0.009X_1 - 0.004X_2 + 0.025X_4 + 0.006X_5 - 0.126X_6 - 0.103X_7 + 1.059X_8$$

Scores of the three common factors can be obtained respectively. Then, according to the variance contribution rate of each factor, the score of each factor is weighted, and finally the comprehensive factor score is obtained by the summation. Therefore, the comprehensive factor scoring formula is

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showed as follows:

$$f = 0.759 f_1 + 0.156 f_2 + 0.086 f_3$$

The table 5 shows the factor scores and their rankings according to each common factor score calculation formula and comprehensive factor score calculation formula.

Table 4 Factor score coefficient table

Indicator	Component		
	1	2	3
X_1	.233	-.073	-.009
X_2	.232	-.073	-.004
X_3	.234	-.077	.000
X_4	.215	-.048	.025
X_5	.298	-.205	.006
X_6	-.222	.673	-.126
X_7	-.177	.606	-.103
X_8	-.010	-.194	1.059

Table 5 Factor score ranking and Comprehensive Ranking

Rank	Score ranking (f_1)	Score ranking (f_2)	Score ranking (f_3)	Comprehensive Ranking(f)
1	Zhengzhou (3.723)	Nanyang(1.924)	Anyang(1.604)	Zhengzhou(3.026)
2	Xinxiang (0.458)	Zhoukou(1.324)	Sanmenxia(0.830)	Xinxiang(0.303)
3	Jiaozuo (0.258)	Zhengzhou(1.114)	Zhumadian(0.756)	Kaifeng(0.041)
4	Kaifeng (0.191)	Xinyang(0.976)	Jiyuan(0.740)	Jiaozuo(0.025)
5	Jiyuan (0.092)	Zhumadia(0.941)	Puyang(0.523)	Anyang(0.008)
6	Luohe (0.002)	Luoyang(0.887)	Shangqiu(0.454)	Luoyang (-0.034)
7	Hebi (-0.036)	Shangqiu(0.319)	Xuchang(0.323)	Shangqiu (-0.111)
8	Pingdingshan(-0.085)	Xinxiang (-0.217)	Zhengzhou(0.303)	Pingdingshan(-0.127)
9	Anyang (-0.093)	Pingdingshan(-0.311)	Zhoukou(0.107)	Jiyuan (-0.154)
10	Luoyang (-0.230)	Xuchang (-0.320)	Xinyang(0.053)	Xuchang (-0.219)
11	Xuchang (-0.259)	Anyang (-0.380)	Luoyang(0.021)	Xinyang (-0.261)
12	Shangqiu (-0.263)	Puyang (-0.408)	Xinxiang (-0.122)	Hebi (-0.279)
13	Sanmenxia (-0.290)	Kaifeng (-0.419)	Pingdingshan(-0.161)	Sanmenxia (-0.287)
14	Puyang (-0.477)	Luohe (-0.526)	Jiaozuo (-0.193)	Nanyang (-0.332)
15	Xinyang (-0.550)	Sanmenxia (-0.889)	Kaifeng (-0.463)	Luohe (-0.359)
16	Nanyang (-0.746)	Jiaozuo(-0.988)	Nanyang (-0.761)	Puyang (-0.381)
17	Zhumadian (-0.847)	Hebi (-1.181)	Hebi (-0.784)	Zhoukou (-0.429)
18	Zhoukou (-0.849)	Jiyuan (-1.845)	Luohe (-3.231)	Zhumadian (-0.431)

Each factor score represents the development level of each city on the indicators included in each factor, and the comprehensive factor score represents the comprehensive level of higher education of

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each city. A positive score for the comprehensive factor means that the level of higher education is above the provincial average, while a negative score means that the level of higher education has not reached the provincial average. It can be seen from Table 5 that there are 5 cities with positive comprehensive factor scores, among which the comprehensive factor scores of Zhengzhou are much higher than those of other cities.

As can be seen from Table 5, the variance contribution rate of the first major factor f_1, namely the scale factor of higher education, is as high as 75%, indicating that the first major factor plays a major role in the comprehensive evaluation of higher education level. From its ranking point of view, ranked in the first place is still Zhengzhou. Zhoukou, Zhumadian and other cities are ranked behind and are under the average level. The second main factor, f_2, is the fund factor of higher education. It can be seen that the score of Luohe is far lower than other cities, while the difference of the score of other cities is not much. The cumulative variance contribution rate of the second and third main factors is only about 25%. Although the education level is mainly affected by the quantity level, the influence of the quality level can not be ignored. Only when the two factors are improved at the same time, the comprehensive education level will be high.

4. Conclusion

Through factor analysis, it is easy to find that every city in He'nan province higher education development level differences, unbalanced phenomenon is outstanding, Zhengzhou has the highest level of higher education, Luohe, Zhoukou and zhumadian are relatively poor, which accord with actual situation. This paper constructed the index evaluation system and the choice of research method has the feasibility and rationality.

On this basis, the following suggestions are put forward: firstly, the platform of mutual help can also be established between cities and regions, so as to narrow the gap in education and achieve common development. Secondly, in order to improve the overall level of higher education in Henan. It can increase fund investment in higher education for high level universities and competitive and characteristic disciplines. Thirdly, the area should continue to make use of its own advantages, according to the needs of local development and traditional characteristic disciplines, strengthen the higher education on the basis of the expansion of higher education, Finally, optimizing the layout structure and hierarchical structure of universities, creating distinctive and strong disciplines, so as to attract, introduce and retain talents.

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